CLAIMS

1. A method of finding a path from a start point to a target point, in multi-dimensional space, comprising:

(a) determining a plurality of points in a physical space, including a start point and an target point;

(b) computing, using a cost function, for said points an accumulated path cost from the start point to a point; representing a minimal cost path from the start point to the point with respect to an optimization criteria;

(c) computing for at least some of said points an estimated-cost-to-target from a point to the target point; and

(d) after computing said costs, determining at least one of a minimal path or a minimal path cost of a path from the start point to the target point in the physical space, wherein the determination is based on said accumulated path costs, and is substantially minimal with respect to the optimization criteria.

2. A method according to claim 1, wherein determining a plurality of points comprises generating a discrete model of said physical world.

3. A method according to claim 1 or claim 2, wherein the accumulated path cost at the target point approximates a minimal accumulated path cost of a path from the start point to the target point in the physical space.

4. A method according to any of claims 1-3, wherein the minimal path determined is made of line segments and each line segment connects two of said points.

5. A method according to claim 4, wherein the minimal path cost has a lower or equal cost than any zigzag path from the start point to the target point, wherein the zigzag path connects a plurality of said points, only by straight line segments.

6. A method according to claim 1, wherein the minimal path determined is a continuous smooth line.

7. A method according to any of claims 1-6, comprising repeatedly updating the accumulated path costs until a stopping criteria is satisfied.

8. A method according to any of claims 1-7, comprising selecting additional points based on said computed costs.

9. A method according to any of claims 1-8, wherein the accumulated path cost of a point is a function of a local cost of the point and an accumulated path cost of at least one neighbor point of the point.

10. A method according to any of claims 1-9, wherein computing said accumulated path cost comprises solving an Eikonal equation.

11. A method according to claim 10, wherein solving comprises employing a finite-difference approximation to an Eikonal equation.

12. A method according to claim 10 or claim 11 wherein computing said accumulated path cost at a point p is carried out by solving an Eikonal equation ||gradient(U(p))|| = L(p), where U(p) is an accumulated path cost function, L(p) is a local cost function, || || is a norm, and where the condition L(p)>0 holds.

13. A method according to claim 11 wherein computing said accumulated path cost (u) at a point P, in a three dimensional grid, is carried out by solving the equation:

$$L^2 = \max\left(u - U_{x-1,y,z}, u - U_{x+1,y,z}, 0\right)^2 + \max\left(u - U_{x,y-1,z}, u - U_{x,y+1,z}, 0\right)^2 + \max\left(u - U_{x,y,z-1}, u - U_{x,y,z+1}, 0\right)^2$$

where L is the local cost and the U's are accumulated path costs for neighbors of P.

14. A method according to any of claims 1-12, wherein computing said accumulated path cost is carried out using cost calculations suitable for a fast marching method.

15. A method according to any of the preceding claims, wherein the points are on a regular grid.

16. A method according to any of claims 1-14, wherein the points are on an irregular grid.

17. A method according to any of claims 1-16, wherein the method examines grid points in a particular order.

18. A method according to any of claims 15-17, wherein neighbors of a point are one or more adjacent grid points to the point.

19. A method according to any of claims 1-18, wherein the points are selected ad-hoc and not according to an a priori grid.

20. A method according to any of the preceding claims, wherein the points are arranged as a graph.

21. A method according to any of claims 1-14, wherein neighbors of a point are one or more grid points at a certain distance or at a certain radius from the point.

22. A method according to any of the preceding claims, wherein determining a path is carried out by a gradient descent method applied on said points with calculated costs.

23. A method according to any of the preceding claims, wherein said cost to target is intentionally underestimated.

24. A method according to any of claims 1-22, wherein said cost to target is intentionally overestimated.

25. A method according to any of claims 1-22, wherein said cost to target is based on a Euclidian distance to said target.

26. A method according to any of the preceding claims, wherein a collection data structure is used for obtaining a point with the smallest cost, wherein adding or removing a value from the collection, and reordering the collection has a computational cost of order O(log M) or better, where M is the number of points in the collection.

27. A method according to claim 26, wherein a heap-type data structure is used for obtaining a point with the smallest cost.

28. A method according to any of the preceding claims, wherein points are categorized and points of different categories are processed differently.

29. A method according to any of the preceding claims, wherein costs of at least one point are updated after an initial calculation.

30. A method according to any of claims 1-28, wherein costs of no points are updated after an initial calculation.

31. A method according to any of the preceding claims, wherein (c) is applied less often than (b).

32. A method according to any of the preceding claims, wherein (c) causes delayed evaluation of less promising points.

33. A method according to claim 32, wherein said delayed evaluation causes a lack of evaluation of at least 40% of points on a grid including said plurality of points.